

**Volume**

**1**

NATIONAL INSTITUTES OF HEALTH

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NIH Enterprise Directory

# NED Business Specification

NIH ENTERPRISE DIRECTORY

# **NED Business Specification**

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# Revision History

Version	Date	Contributors	Summary
DRAFT 1	July 12, 2004	Keith Gorlen	First Draft

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We think we know what we are doing. We have always thought so. We never seem to acknowledge that we have been wrong in the past, and so might be wrong in the future. Instead, each generation writes off earlier errors as the result of bad thinking by less able minds—and then confidently embarks on fresh errors of its own.

We are one of only three species on our planet that can claim to be self-aware, yet self-delusion may be a more significant characteristic of our kind.

Michael Crichton, *Prey*

## INTRODUCTION

### Purpose

The [NIH Enterprise Directory](#) (NED) enables application programs and users to easily find information about the people who work at NIH. Mainly, NED contains information that **identifies** a particular individual, such as a person's name, NIH ID number, date of birth, place of birth, Social Security Number (SSN), and ID photo, and information to **locate** or contact a person at work or home, such as their email address, postal and delivery addresses, telephone numbers, organizational affiliation and status (Employee, Contractor, Guest), and so on.

NED is the best source for NIH directory information because it includes all types of workers (Employees, Fellows, Contractors, Tenants, Guests, and Volunteers), it represents data values consistently to simplify searching and report generation, it is connected to NIH business processes for registration/deregistration, and it is readily accessible. As a result, NED is used by many enterprise-wide applications at NIH.

### Benefits

By providing a convenient, single, logical source of identity and locator information, NED eliminates the need for application-specific repositories of people data, thus reducing the cost of application development and maintenance. This also reduces the amount of redundant data

entry, since NED provides a single place to update the people data used by several major applications.

NED makes deregistration of individuals occur more reliably when they leave NIH. Applications connected to NED can take advantage of this to deactivate accounts and revoke authorizations, thereby improving security. For example, when an individual is deregistered in NED, this deactivates their record in the ID badge system, which revokes their card key door lock access.

Applications can also use linking information kept in NED to find the records belonging to an individual that are maintained by other applications, thus making new uses of the data possible. For example, [NIH Login](#) allows users to authenticate using their [NIH Active Directory](#) account, and NIH Login-enabled applications such as the [NIH Business and Research Support System](#) (NBRSS) and the [Integrated Time and Attendance System](#) (ITAS) can then use NED to locate an authenticated user's record in the [Human Resources Database](#) (HRDB).

## NIH Environment

The [National Institutes of Health](#) (NIH) is the steward of medical and behavioral research for the United States. It is an Agency under the U.S. [Department of Health and Human Services](#), and is comprised of the [Office of the Director](#) and 27 [Institutes and Centers](#) (ICs), subdivided into more than **2,300 organizational units** (OUs).

NIH headquarters and most research laboratories are located on the main campus in Bethesda, Maryland. The NIH also has facilities in the Rockville, Maryland area and at:

- the [NCI Frederick Cancer Research and Development Center \(FCRDC\)](#) at Fort Detrick in Frederick, Maryland;
- the [National Institute of Environmental Health Sciences'](#) main facility in Research Triangle Park (RTP), North Carolina;
- the [NIH Animal Center](#) in Poolesville, Maryland;
- the [National Institute on Aging's Gerontology Research Center](#) in Baltimore, Maryland;
- the [Division of Intramural Research of the National Institute on Drug Abuse](#), also in Baltimore;
- the National Institute of Allergy and Infectious Diseases' [Rocky Mountain Laboratories](#) in Hamilton, Montana; and,
- smaller field units in Phoenix, Arizona, Boston, Framingham, and Waltham, Massachusetts, Detroit, Michigan, and Jackson, Mississippi.

A total of over **340 buildings** at these sites are occupied by a workforce of over **40,000 people**, including 18,000 government employees, 4,000 fellows, 13,000 contractors, and 5,000 tenants, volunteers, and guests.

See the [NIH Almanac](#) for further information about the NIH environment.

## NED Documentation Suite

### NED Business Specification

The [NED Business Specification](#) (this document) describes the purpose and benefits of NED, the environment in which it operates, the background of its planning, design, development, and deployment, and the functions it performs. It is intended for a general audience, and is prerequisite reading for all other NED documentation.

### NED System Specifications

The [NED System Specification](#) manual describes the concepts underlying the components of the NIH Enterprise Directory: LDAP directory servers, relational database servers, and the meta-directory join engine (JE). It then uses these concepts to describe how NED's connections to external data servers and applications are implemented and operate. Of these, the connection to NEDWeb is particularly important because of the critical functions this application performs. This manual is prerequisite reading for all other NED documentation except the *NED Business Specification*.

### NED Developer's Guide

The [NED Developer's Guide](#) describes how to design, develop, test, and deploy a new connection to NED. It assumes that the reader is familiar with *NED System Specification*, and with programming in Perl and configuring the Critical Path Meta-directory Server.

### NED Administrator's Guide

The [NED Administrator's Guide](#) describes how to install, maintain, and troubleshoot NED and its subsystems, including the directory server, the meta-directory server and its connections, and the NEDWeb application. It assumes familiarity with *NED System Specification*, the Lightweight Directory Access Protocol (LDAP), and the Structured Query Language (SQL).

### NED Programmers' Reference

The [NED Programmer's Reference](#) describes in detail:

- the data structures used by the LDAP directory servers, relational database servers, and the meta-directory join engine;
- the application programming interface to the NED Class Library;
- the operation of NED custom connectors;
- the command line interface and use of record linking and miscellaneous utilities; and,
- the join engine configuration.

This manual assumes familiarity with *NED System Specification*, the *NED Developer's Guide*, the *NED Administrator's Guide*, programming in Perl, configuring the Critical Path Meta-directory Server, LDAP, and SQL.

If you want to understand today, you have to search yesterday.

Pearl Buck

## BACKGROUND

### Information Technology Central Committee

In 1996, the NIH Director's Leadership Forum agreed to examine ways to centrally manage selected elements of IT at NIH and appointed an Information Technology Central Committee (ITCC) of senior Institute and Center (IC) representatives to develop specific recommendations for improving the management of NIH's information technology (IT) resources. In developing its recommendations, the ITCC was asked to review previous work done by many NIH IT committees and forge a consensus on specific actions to be taken in the areas of IT organizational structure, interoperability, and security.

Among the recommendations the ITCC made to the NIH Director in December, 1996, was the development of a “centrally coordinated NIH electronic directory”. The ITCC envisioned this directory as coordinating or replacing the separate directories then used for email, personnel, parking, etc., and also implementing “deregistration activities”, since the committee recognized that accounts and authorizations for services left active after their owners separated from NIH posed an increasing security risk. The NIH Director delegated the implementation of this and the other ITCC recommendations to the NIH Acting CIO.

### Architectural Management Group

In 1994, NIH formed an information technology [Architectural Management Group](#) (AMG) consisting of representatives from each of NIH's ICs. The AMG's broad goal was to define a uniformly supported, interoperable, IT architecture that enables NIH users to transparently access and use from their workplaces the platforms, processes, and data they need to do their work.

The NIH Acting CIO charged the AMG to provide strategies for the implementation of the ITCC recommendations, including the electronic directory, in February, 1997.

The AMG's [Report on Interoperability at the NIH](#) issued in May, 1997, recognized that an electronic directory would require long-term NIH executive commitment and resources, and made the following recommendations:

- Establishment of the NIH centrally-supported electronic directory is a critical priority.
- Development and implementation of the directory is a prerequisite to the emplacement of network security at the NIH.
- The directory must be recognized by all ICs as the authoritative source for directory information.
- Unique personal identifiers (not the Social Security Number) must be defined. This will allow integration with systems based on relational databases.
- Base directory design on both Lightweight Directory Access Protocol (LDAP) and Structured Query Language (SQL) access.
- Declare directory presence a prerequisite for NIH services.
- Establish central directory functional and technical committees.

## AMG Technical Subcommittee

The NIH Acting CIO approved the formation of a small Technical Subcommittee, the [AMG TSC](#), to further develop the concept and design of an NIH electronic directory service. The AMG TSC was comprised of technical experts from several ICs plus a consultant hired from [The Burton Group](#) (TBG), and met regularly from August, 1997, through November, 1998.

The architecture described in the AMG TSC's final [Architecture Review](#) issued in November, 1998, included the following features, which have been implemented in NED:

- An **NIH ID Number** to uniquely and persistently identify every person represented in the directory
- A **directory schema** defining the data elements (or **attributes**) that describe the people represented in the directory
- A **directory server** to store directory data
- A means to make directory data accessible via the **Structured Query Language (SQL)**
- A **meta-directory**, also called a **join engine (JE)**, to **synchronize** directory data with other repositories of people information

- **NEDWeb**, a web application used by NIH Administrative Officers to manage directory content
- An **audit trail** to record changes to directory content

The AMG TSC's directory architecture also included the following features, which have not been implemented in NED due to technical, practical, or resource limitations:

- A 4 to 8-digit **Personal Identification Number (PIN)** to enable individuals to prove ownership of their NIH ID Numbers
- A hybrid ("rich") **Directory Information Tree (DIT)** with organizational and geographical views of people data
- A means for external applications to directly access directory data via the [Lightweight Directory Access Protocol \(LDAP\)](#)
- **Exception reports** to notify NIH Administrative Officers of differences between directory data and that in other repositories

## NIH Identification Number

One of the first issues addressed by the AMG TSC was the design of an NIH Unique Identifier (UID) that would be used to reliably associate with an individual all the related information stored in the electronic directory and various other NIH systems and databases. After considering many alternatives and surveying practices at other organizations, the AMG TSC recommended a 10-digit NIH ID number with the following characteristics:

- **SCOPE:** An NIH ID will be assigned to every individual registered in the NIH electronic directory.
- **UNIQUENESS:** No two individuals will be assigned the same NIH ID number.
- **SINGULARITY:** An individual will not be assigned more than one NIH ID number.
- **PERSISTENCE:** An individual will have the same NIH ID number throughout their entire career.
- **FORM:** The NIH ID number will be a 10-digit decimal number displayed in the form *ddd-dddd-dd*<sup>1</sup>; for example, 001-0147-906. The rightmost digit will be a check digit<sup>1</sup> computed from the other nine digits.

The AMG adopted this recommendation at their quarterly meeting on October 15, 1997.

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<sup>1</sup> The NIH ID number uses the ISO 7064 MOD 10,11 check digit standard.

## Privacy Act Clearance

Soon after it began meeting, the AMG TSC realized that individual identifying information, such as the SSN and date and place of birth, would need to be collected in order to make NIH ID numbers unique and persistent. Before collecting such information, NED needed to be established as a new system of records and a Privacy Act clearance obtained. The NED Project Team began this process in October, 1997, and the [\*NED System of Records and Privacy Act Clearance\*](#) became effective on May 24, 2000.

## Data Server Surveys

From July, 1998, through November, 1999, the NED Project Team surveyed the major NIH-wide databases and associated business processes in order to determine what would be necessary to connect them to the NED meta-directory. The NED Project Team prepared a [\*Data Server Survey Form\*](#) based on one used by TBG, met with database owners and administrators to complete the form and obtain access to or samples of the data involved, and analyzed the data.

Generally, the survey and data analysis revealed that:

- No database contained records for all types of workers.
- No database contained most, or even many of the data elements to be included in NED.
- Rarely did any two databases contain a common key, such as the SSN, to make it simple to join records identifying the same individuals.
- Databases and associated business processes were rarely documented.
- The databases driving payroll and visas contained the most complete, accurate, and consistently-coded information, but usually did not contain locator information. They also operate in arrears, which means that the strong identity information they contain is not available in time for “Entrance on Duty” (EoD) day purposes such as issuing ID badges.
- The quality of data in other types of databases was typically poor, suffering from one or more of the following problems: missing/invalid values, inconsistently coded values, old data, records not removed for workers who have left, and duplicate records.
- Database technology and associated business processes did not change often. Most systems were at least 10 years old, and two about 20 years old.
- No single, complete, up-to-date sources for building and organization information existed.



In short, utilizing existing data and business processes to construct NED was going to be more of a challenge than anyone anticipated.

## Directory Technology Assessment

As the AMG TSC's directory architecture neared completion, it commissioned TBG to assess commercially available directory and meta-directory products and services. Vendors considered included ISOCOR, Zoomit, Control Data Systems, Open Directory, and Netscape. As reported in the [NED Technology Assessment](#), TBG determined that ISOCOR and Zoomit had the most suitable offerings.

The NED Project Team acquired evaluation copies of the Zoomit VIA and ISOCOR MetaConnect meta-directory products in late 1998, conducted proof-of-concept testing, and chose MetaConnect, even though it was still in beta test. MetaConnect had a more flexible architecture, better support for event-driven operation, and could be easily extended with customer-supplied [Perl](#) scripts rather than Zoomit's proprietary language.

[Critical Path](#) (CP) acquired ISOCOR<sup>2</sup> in October, 1999. CIT purchased MetaConnect late in 1999 after it became generally available, and also purchased CP's X.500/LDAP Global Directory Server (GDS).

## Directory Steering Committee

The [Directory Steering Committee](#) (DSC) was established in February, 1999, to work with the NED Project Team to identify system requirements and address the many implementation issues associated with a project of this scope. Composed primarily of NIH Administrative Officers (AOs) from representative ICs, the DSC met on a biweekly basis through October 1999 to consider issues such as user interface design, security and Privacy Act considerations, business processes, potential uses of NED, and community education and outreach.

The DSC and the NED Project Team engaged in joint design and development of [NEDWeb](#), the web application AOs and Administrative Technicians (ATs) use to register, update, and deregister entries in NED for the individuals for whom they are responsible. The major areas the DSC addressed included:

- data elements to include in NED, and from where to obtain them,
- authoritative sources for IC and other data elements,

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<sup>2</sup> AOL/Netscape licensed the MetaConnect version 1 source code from ISOCOR in January, 1999, and the resulting product came to be sold by Sun Microsystems as [Netscape Metadirectory Services](#). Microsoft acquired Zoomit in July, 1999, and evolved their Via product into the [Microsoft Identity Integration Server](#) (MIIS). Novell partnered with ISOCOR in developing an NDS eDirectory connector for MetaConnect until July, 1999, when Novell announced it would develop its own meta-directory product, dirXML, which became generally available in July, 2000. Due to the influence of the partnership, dirXML (now known as [Nsure Identity Manager](#)) offers functionality similar to that of MetaConnect.

- organizational and person status classifications,
- AO/AT authorization control and workflow,
- process for reassigning an individual to a different IC,
- design of the NEDWeb user interface, and
- data sources and strategy for “seeding” the NED database

The DSC and the NED Project Team also developed a plan for conducting a NEDWeb pilot test.

## NEDWeb Pilot Test and Deployment

Concurrently with NEDWeb design and development, the NED Project Team developed **connectors** to the seven data sources<sup>3</sup> used to initially populate the NED database. Connectors are software components that read source data and prepare it for matching and loading into the meta-directory. Though designed for compatibility with the selected MetaConnect product, the connectors were run stand-alone to load NED database tables in Oracle since the MetaConnect product was still in beta test, and not yet generally available.

To identify all records in the source databases that referred to the same individual, the NED Project Team adapted software and methodology developed by the U. S. Bureau of the Census Statistical Research Division for performing **probabilistic record linking**. This process generated an NIH ID number for each person and assigned it to all linked records, thus allowing them to be joined and their data elements merged into a single record per person in the NED test database.

The NEDWeb pilot test began in November, 1999. After attending trial training sessions developed and conducted by the NED Project Team, AOs and ATs from CIT, NCRR, NHLBI, NIAA, and NINR used NEDWeb to perform simulated work on the test database. Feedback from the pilot test resulted in many improvements and corrections for problems.

When the NED System of Records and Privacy Act Clearance became effective in May 2000, the NED Project Team reinitialized the NED database with fresh data from the seven sources, and production use of NEDWeb began. By August, 2000, NEDWeb was successfully deployed to all ICs except NIEHS<sup>4</sup>.

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<sup>3</sup> The HHS Human Resources Database (HRDB), Fellowship Payment System (FPS), J. E. Fogarty Database of Visiting Fellows and Scientists (JEFIC), Parking and ID Badge system (PAID), Integrated Time and Attendance System (ITAS), NIH Telephone Directory, and NIH Email Directory and Forwarding Service (PH)

<sup>4</sup> NIEHS AOs continued to use their own directory database and content management web application until mid-2002, when they began using NEDWeb. Until then, the only means provided for managing NIEHS people in NED was the meta-directory, which began auto-registering/deregistering NIEHS Employees and Fellows and updating their locator information via PH in November, 2001.

## NIH ID Badge and Card Access System

Fortuitously, the NIH [Division of Public Safety](#) (DPS) began preparing in 1998 to replace NIH's outdated ID badge and card access systems, including replacing all card access readers installed on the NIH Bethesda campus and reissuing 25,000 ID badges. This created the opportunity to integrate NED with the new [Andover Controls](#) [Continuum](#) access control system.

The NED Project Team and DPS staff began meeting in December, 1999, to determine requirements and agree upon the NED/Continuum interface specification. The interface was subsequently developed, successfully tested in October, 2000, and deployed in December, 2001, to support the campus-wide rebadging effort, which began in January, 2002.

## Meta-Directory Development and Deployment

Development of the NED meta-directory based on Critical Path MetaConnect v2.1 and GDS v3.0 products began in February, 2000. This involved:

- installing and configuring the LDAP directory server with the schema developed by the AMG TSC,
- integrating the connectors and probabilistic record linking software developed for the pilot test with the meta-directory,
- developing new connections to the NEDWeb-maintained production database, the new NIH ID Badge and Card Access system, and NIH Telephone Directory, and
- programming the meta-directory to flow the dozens of data elements among these connected repositories as determined by the data server surveys and the DSC.

The NED Project Team immediately encountered serious defects in both GDS and MetaConnect. CP resolved these sufficiently by June so that the software was usable; however, subsequent releases introduced new problems which CP did not resolve, so both products effectively became unsupported. Development proceeded only by working around problems as they were discovered.

The meta-directory was deployed in November, 2001, with connections to the four payroll/visa systems and the email directory<sup>5</sup>. Connections to the new NIH ID Badge and Card Access system and NIH Telephone Directory and were added in December, to the NIH Clinical Center Library Patron Database in April, 2002, and to DB2 on OS/390 in May, 2002.

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<sup>5</sup> HRDB, FPS, Fellowship Payment System II (FPS2), JEFIC, and PH

## NIH Login

CIT began the [NIH Login](#) project in July, 2002, to provide a single authentication mechanism for NIH Web applications, particularly NBRSS, which was due to go into production in March, 2003.

NIH Login uses [Netegrity SiteMinder](#) to manage access to web applications and [NIH Active Directory](#) (AD) to perform the actual authentication of a user's account name and password. Upon successful authentication, SiteMinder supplies the user's account name to the web applications to which it controls access. NED's role is to enable these applications to use the authenticated account name to find the account owner's NED entry, which is required by applications such as NBRSS and ITAS.

To accomplish this, NED needed to read the account names and other information from over 35,000 AD entries spread across 19 AD domains, match these to NED records, and write them to the DB2 NED table on OS/390. The NED Project Team developed several stand-alone Perl scripts to temporarily perform these synchronization functions once per day, since an AD connector was not available for MetaConnect v2.1. These were deployed for production use in September, 2002.

NIH Login was deployed for production use in September, 2003, and NEDWeb became NIH Login-enabled in January, 2004.

## Meta-Directory Upgrade

Due to lack of support from the vendor for GDS v3.0 and MetaConnect v2.1, the NED Project Team declared a moratorium on making additional enhancements to the NED meta-directory and began working in February, 2002, on upgrading to the latest versions of these CP products: InJoin Directory Server (IDS) v4.0 and InJoin Meta-Directory (IMD) v3.4. The upgrade was a major undertaking because:

- the meta-directory application program interface (API) had changed, requiring extensive changes to the NED connectors;
- v2.1 defects had been fixed, allowing most work-arounds to be removed from the NED software;
- new meta-directory features enabled the NED software to be simplified;
- correcting design problems and taking advantage of new features necessitated changes to directory and Oracle database structures, so the upgrade involved migrating and transforming NED production data; and,
- many serious defects were discovered in IMD, including inadvertent removal of v2.1 functionality which NED required.

Fortunately, the new version of the meta-directory software included better diagnostic tools, and CP provided good support and resolved product problems in a timely manner. The NED Project Team shut down NED for a weekend and successfully performed the upgrade in November, 2003. Once again running supported software, it was possible to add new connections, so a connection to the Integrated Time and Attendance System (ITAS) was deployed in March, 2004.



A little inaccuracy sometimes saves a ton of explanation.

H. H. Munro (Saki)

## FUNCTIONAL OVERVIEW

As described in the Introduction, NED manages identity, organizational, and locator information for all NIH workers. Identity information--distinctive information about an individual that never or rarely changes--includes name, sex, date of birth, place of birth, ID photo, and other information protected by the Privacy Act. The name of the organization sponsoring an individual and their classification (Employee, Fellow, Contractor, Tenant, Volunteer, or Guest) are the main elements of organizational information. Locator information consists of home and work telephone numbers, building addresses, email addresses, and so forth.

NED acquires and coordinates identity, organizational, and locator information among other systems and databases, including:

- NIH ID Badge and Card Access System
- NIH [Human Resources Database](#) (HRDB)
- NIH [Fellowship Payment System II](#) (FPS2)
- J.E. Fogarty database of Visiting Fellows and Scientists (JEFIC)
- NIH [Email Directory and Forwarding Service](#) (PH)
- [NIH Active Directory](#) (AD)
- [NIH Login](#)
- NIH [Telephone and Services Directory](#)
- NIH [Integrated Time and Attendance System](#) (ITAS)

- NIH Clinical Center Library Patron Database
- [Web Sponsor](#)
- [NIH Business and Research Support System](#) (NBRSS)
- [Parking and Transhare System](#) (PARTS)
- [NIH Intramural Database](#) (NIDB)
- NHLBI eDirectory
- [NIEHS People Database](#)

To accomplish this, NED:

- binds individual identities to NIH ID numbers;
- enables NIH Administrative Officers (AOs) and Administrative Technicians (ATs) to register, update, and deactivate records for NIH workers;
- enables individuals to update their own records;
- connects to other systems and databases via a wide variety of protocols and interfaces;
- parses, validates, and standardizes about 80 identity and locator data elements;
- finds and links records that identify the same individual;
- selects and merges all data elements for an individual into a single meta-directory record; and,
- creates, updates, and deletes records in connected systems in response to external events, as determined by nearly 1,000 custom business rules.

The result is that NED and all systems and databases to which it is connected contain up-to-date, consistent, standardized identity, organizational, and locator information for the entire NIH workforce.

## **NED Physical System Diagram**

FIGURE 1 depicts the physical components of NED and how these connect to the other major systems.



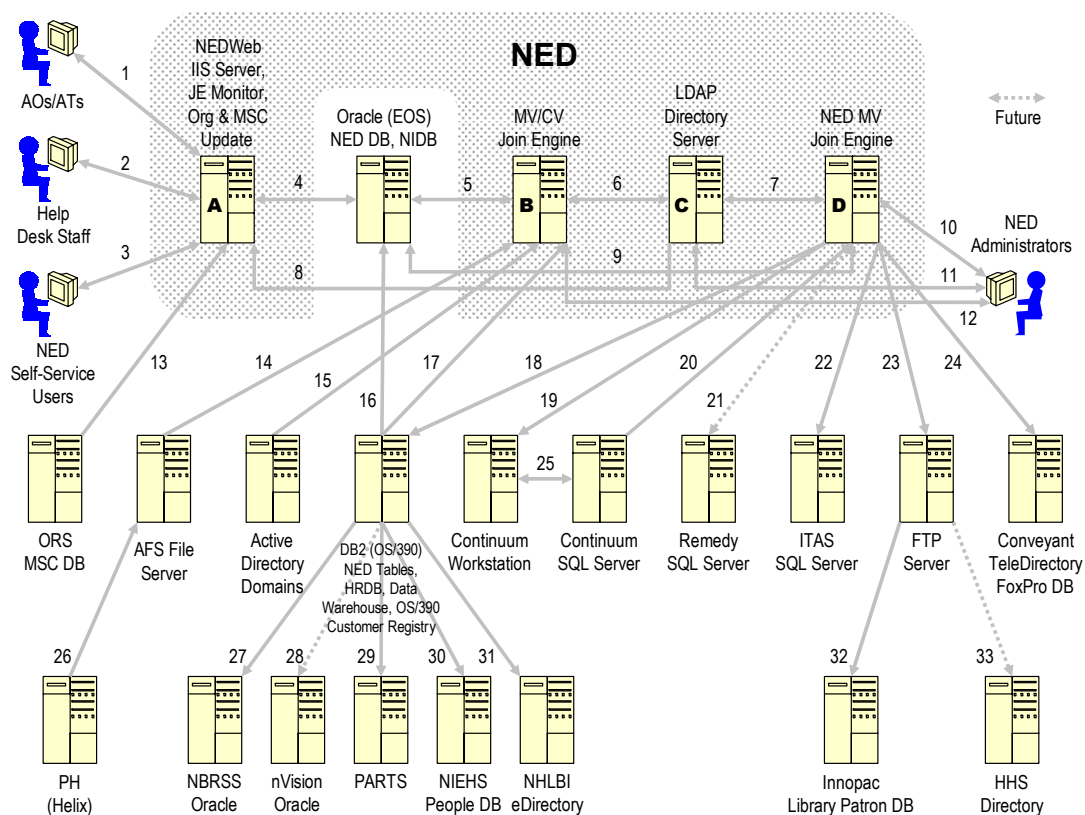


FIGURE 1 NED Physical System Diagram

TABLE 1 describes the numbered connections shown in FIGURE 1.

TABLE 1 NED Connections Summary

Connection Number	Protocol	Purpose
1	HTTPS	Web browsers used by AOs and ATs communicate with NEDWeb application running under Microsoft Internet Information Services (IIS).
2	HTTPS	Web browsers used by NIH Help Desk staff communicate with AD/NED Link Editor application running under IIS. This application allows authorized staff to change the NIH Active Directory account name enabled for use with NIH Login.
3	HTTPS	Web browsers communicate with NEDWeb Self-Service application running under Microsoft Internet Information

Connection Number	Protocol	Purpose
		Services (IIS).
4	Oracle SQL*Net	NEDWeb, NEDWeb Self-Service, AD/NED Link Editor, and organization and mailstop update tasks access Oracle database tables.
5	Oracle SQL*Net	Critical Path™ Meta-Directory Server (JE) on machine <b>B</b> accesses Oracle database tables.
6	LDAP	Critical Path™ Meta-Directory Server (JE) on machine <b>B</b> accesses Critical Path™ Directory Server on machine <b>C</b> .
7	LDAP	Critical Path™ Meta-Directory Server (JE) on machine <b>D</b> accesses Critical Path™ Directory Server on machine <b>C</b> .
8	LDAP	JE Monitor application accesses Critical Path™ Directory Server on machine <b>C</b> . This application alerts the NED team via email when it detects a meta-directory failure or inactivity.
9	Oracle SQL*Net	Critical Path™ Meta-Directory Server (JE) on machine <b>D</b> accesses Oracle database tables.
10	Telnet	Critical Path™ Management Center used by NED team to manage Critical Path™ Meta-Directory Server (JE) on machine <b>D</b> .
11	LDAP	Critical Path™ Management Center used by NED team to manage Critical Path™ Meta-Directory Servers on machines <b>D</b> and <b>B</b> .
12	Telnet	Critical Path™ Management Center used by NED team to manage Critical Path™ Meta-Directory Server (JE) on machine <b>B</b> .
13	Microsoft SQL Server	Mail stop code (MSC) update task reads MSC database managed by ORS.
14	AFS RX	PHConnect custom Perl connector to JE reads daily snapshot files of NIH Email Forwarding Service and Directory (PH).
15	LDAP	AD/NED Perl synchronization script reads entries in NIH Active Directory (AD).
16	IBM DB2	Organizational code update task reads HRDB DB2 tables via the Oracle database server (EOS) and the Oracle Transparent

Connection Number	Protocol	Purpose
		Gateway to DB2.
17	IBM DB2	FPS2Connect, HRDBConnect, and JEFICConnect custom JE Perl connectors read HRDB, FPS II, and JEFIC DB2 tables.
18	IBM DB2	MVSCConnect custom JE Perl connector writes NED data to DB2 tables.
19	CIFS	ONEIDConnect custom JE Perl connector writes NIH ID Badge and Card Access System commands and data to files in folder shared from Microsoft Windows machine.
20	Microsoft SQL Server	ONEIDConnect custom JE Perl connector reads ID Badge and Card Access System database tables.
21	ARS	HELPCConnect custom JE Perl connector writes data to the NIH Help Desk customer database.
21	Microsoft SQL Server	HELPCConnect custom JE Perl connector reads data from the NIH Help Desk customer database.
22	Microsoft SQL Server	JE SQL Server connector writes data to NIH Integrated Time and Attendance System (ITAS) database.
23	CIFS	FTP Server reads NED data from shared folder on machine <b>D</b> .
24	CIFS	Conveyant TeleDirectory host interface (hostif) application reads NED data and commands from files written by OPERConnect custom JE Perl connector to shared folder on machine <b>D</b> .
25	Microsoft SQL Server	Continuum Personnel Data Import (PDI) application reads NED data and commands from files in local shared folder and accesses Continuum database.
26	AFS RX	NIH Email Forwarding Service and Directory (PH) scripts write daily snapshot files.
27	Connect:Direct	NIH Business and Research Support System (NBRSS) application reads files produced from NED and HRDB DB2 tables and loads data into Oracle Employee table.
28		nVision data warehouse application on Oracle reads NED

Connection Number	Protocol	Purpose
		DB2 tables.
29	IBM DB2	NIH Parking and Transhare System (PARTS) application reads NED DB2 tables.
30	IBM DB2	NIEHS People Database application reads NED DB2 tables.
31	IBM DB2	NHLBI eDirectory application reads NED DB2 tables via Novell Nsure Identity Manager connector.
32	FTP	NIH Library Innopac application reads data files written by CCLIBConnect custom JE Perl connector.
33	FTP	HHS Directory application reads data files written by HHSConnect custom JE Perl connector.

The following tables describe the configurations of the server machines (labeled A, B, C, and D in FIGURE 1) for the production, test, and development NED instances.

TABLE 2 NED Production Server Configurations

Machine	Configuration
A	<ul style="list-style-type: none"> <li>▪ HP Proliant DL380 G3</li> <li>▪ Quad Intel Pentium IV 2.8GHz processors</li> <li>▪ 2.5GB physical memory</li> <li>▪ Dual 17GB disk drives</li> <li>▪ Microsoft Windows 2000 Server (Version 5.0.2195 - Service Pack 3, Build 2195)</li> </ul>
B	<ul style="list-style-type: none"> <li>▪ Compaq DL360 G2s</li> <li>▪ Dual 1.4 GHz processors</li> <li>▪ 1.2 GB physical memory</li> <li>▪ Mirrored 18.2 GB disk drives</li> </ul>

<b>Machine</b>	<b>Configuration</b>
	<ul style="list-style-type: none"> <li>▪ Windows 2000 Server SP4</li> </ul>
C	<ul style="list-style-type: none"> <li>▪ Sun 280R</li> <li>▪ Dual UltraSPARC-III+ 900MHz processors</li> <li>▪ 4096MB physical memory</li> <li>▪ Dual 72GB disk drives</li> <li>▪ Solaris 8</li> </ul>
D	<ul style="list-style-type: none"> <li>▪ Compaq DL360 G2s</li> <li>▪ Dual 1.4 GHz processors</li> <li>▪ 1.2 GB physical memory</li> <li>▪ mirrored 18.2 GB disk drives</li> <li>▪ Windows 2000 Server SP4</li> </ul>

TABLE 3 NED Test Server Configurations

<b>Machine</b>	<b>Configuration</b>
A	<ul style="list-style-type: none"> <li>▪ Compaq 1850/R</li> <li>▪ Dual Intel Pentium III 548MHz processors</li> <li>▪ 512MB physical memory</li> <li>▪ 17GB disk drive</li> <li>▪ Microsoft Windows 2000 Server (Version 5.0.2195 - Service Pack 4 Build 2195)</li> </ul>
B	<ul style="list-style-type: none"> <li>▪ Compaq DL360 G2s</li> <li>▪ Dual 1.4 GHz processors</li> <li>▪ 1.2 GB physical memory</li> </ul>

Machine	Configuration
	<ul style="list-style-type: none"> <li>▪ mirrored 18.2 GB disk drives</li> <li>▪ Windows 2000 Server SP4</li> </ul>
C	<ul style="list-style-type: none"> <li>▪ Sun E250</li> <li>▪ Dual UltraSPARC-II 400MHz processors</li> <li>▪ 2048MB physical memory</li> <li>▪ 2X 36GB disk drives, 1X 9GB disk drive</li> <li>▪ Solaris 8</li> </ul>
D	<ul style="list-style-type: none"> <li>▪ Compaq DL360 G2s</li> <li>▪ Dual 1.4 GHz processors</li> <li>▪ 1.2 GB physical memory</li> <li>▪ Mirrored 18.2 GB disk drives</li> <li>▪ Windows 2000 Server SP4</li> </ul>

## Identity Binding

**Identity binding** is the process of assigning a single, unique, persistent NIH ID number to each individual identity in NED. Typically, the NEDWeb application does this when AOs register people, but the JE also binds identities automatically when AOs fail to do so and records appear first in authoritative human resource (HR) systems such as HRDB, FPS II, and JEFIC.

## Content Management

The NEDWeb application is also the primary means of performing **content management**: adding, updating, and deleting entries for people in NED. AOs perform all three functions for the people in the organizations they administer, while individuals can view all, but update only a subset of the information in their own NED entries via the NEDWeb Self Service application.

## ID Badge Provisioning

The NIH ID Badge and Card Access System is built on the [Andover Controls Continuum](#) product and operated by the NIH [Division of Police](#). NED **provisions** the ID badge system with records for people; that is, NED is the only means by which ID badges can be authorized, renewed, replaced, and revoked. AOs perform these four badge-related functions for the people in the organizations they administer by using NEDWeb.

The NED JE bidirectionally exchanges data with Continuum. NED sends add, modify, and deactivate commands and the NIH ID number, name, legal name, organizational status (employee type), IC, building, room number, telephone number, and badge title to Continuum. When a badge is issued, NED detects this and reads the ID photo and ID badge number back from Continuum.

NIH ID badges have the badge holder's NIH ID number printed on the bottom front of the badge, and encoded on a magnetic stripe and barcode on the back. Applications such as the NIH Clinical Center Library Patron Database and Parking and Transhare System read the barcode to determine a user's identity.

When an individual separates from NIH, changes their organizational status (from Employee to Contractor, for example), or is reassigned to a different IC, NED deactivates their record in the ID badge system, which revokes their card key door lock access.

## Reconciliation with HR Systems

NIH utilizes four Human Resources (HR) systems:

- the [Enterprise Human Resources and Payroll](#) (EHRP) system, managed by the [HHS Program Support Center](#) (PSC);
- the Commissioned Officer Personnel Payroll System (COPPS), also managed by the HHS PSC;
- the [Fellowship Payment System II](#) (FPS2), managed by NIH; and,
- the J.E. Fogarty database of Visiting Fellows and Scientists (JEFIC), also managed by NIH.

These systems are read-only, authoritative sources for the identity and organizational information they contain, and for whether or not an individual's record should be active in NED. Thus, when information in one of these HR systems differs from that in NED, the JE reconciles the difference by "correcting" NED to agree with the HR system.

The EHRP, COPPS, and FPS2 systems are payroll systems, which inherently operate in arrears; that is, an individual's information need not be current in the system until the end of a pay period. NED compensates for this latency by allowing AOs to:

- bind an individual's identity to an NIH ID number after they are hired, and schedule their registration for their Entrance on Duty (EoD) date;
- override information for which an HR system is authoritative as long as it is more current than that in the authoritative source; and,
- deregister an individual on their separation date, prior to the end of their last pay period.

#### HRDB

NED obtains identity and organizational data from EHRP and COPPS via a single feed from the NIH [Human Resources Database](#) (HRDB). CIT's [Division of Enterprise and Custom Applications](#) (DECA) obtains a snapshot of the NIH employee records in both these databases at the end of each pay period and combines them to create the HRDB tables in [DB2](#).

NED considers **all** individuals with records in the HRDB, and **only** these individuals, to be **Employees**. The [NIH Almanac](#) gives a breakdown of the [number and types of NIH employees](#) represented in the HRDB.

#### Fellowship Payment System II

The NIH [Fellowship Payment System II](#) (FPS2) maintains information for intramural Fellows for the purpose of making monthly stipend payments. It is a component of the NIH [Administrative Database](#) (ADB), supported by CIT/DECA.

CIT/DECA loads a snapshot of FPS2 data into the [NIH Data Warehouse](#) once each day. NED uses a view of currently active FPS2 records in the data warehouse to obtain identity and organizational information.

NED considers **all** individuals with records in FPS2, and **only** these individuals, to be **Fellows**.

#### JE Fogarty Database

The [J. E. Fogarty International Center](#) database (JEFIC) contains current and historical visa, identity, education, training, and locator information on about 2,500 Fellows, Scientists, Guests and Volunteers visiting from foreign countries to participate in NIH research and training programs. The database is maintained by immigration specialists in the NIH [Division of International Services](#), who enter data provided by AOs on paper forms and obtained from other sources.

CIT/DECA loads a snapshot of JEFIC data into the [NIH Data Warehouse](#) once each month. NED uses a view of currently active JEFIC records in the data warehouse to obtain identity, organizational, and locator information. NED uses locator information from JEFIC only to initialize building, room, and work telephone number in NED entries, since JEFIC is read-only and locator information is typically not kept up-to-date in JEFIC after EoD.

The JEFIC population overlaps that of the HRDB and FPS2 databases. Visiting Fellows receive monthly stipends, have records in FPS2, and are classified in NED as Fellows. Visiting Scientists receive salaries, have records in the HRDB, and are classified in NED as Employees. Visiting



Guests and Volunteers are not paid, have records in neither FPS2 nor the HRDB, and are classified in NED as Guests and Volunteers, respectively.

## Email Directory and Forwarding Service

The NIH [Email Directory and Forwarding Service](#), also known as the **PH** service because it supports the “[ph](#)” program for Macs and UNIX machines, is the precursor of NED. It is a simple meta-directory, developed and operated by the CIT [Division of Computer System Services](#) (DCSS), and hosted on the [Helix](#) system. It is intended for email address book applications, and contains name, IC, and locator information for those individuals with NIH email accounts.

NED reads a snapshot of PH daily to update email addresses. Since PH is read-only, NED uses PH locator information only to initialize building, room, and work telephone, FAX, and pager numbers in NED entries.

PH also forwards email sent to “@nih.gov”, a function NED does not perform.

## NIH Active Directory

Microsoft [Active Directory](#) (AD) is an LDAP-accessible directory service used by Microsoft Windows platforms and other applications to store and retrieve information about enterprise resources such as user accounts, computers, printers, and servers. Most importantly, it provides authentication services for Windows and NIH Login, and an address book for Microsoft Exchange 2003 email.

The [NIH Active Directory](#) configuration currently consists of an NIH parent domain and more than 15 independently-administered child domains with a total of over 40,000 user account entries. NED reads a snapshot of every domain daily, matches AD user account entries to NED entries, and populates NED entries with AD domain and user account names. In response to trouble calls, the NIH Help Desk can manually override the AD domain and user account name associated with an individual’s entry in NED to make corrections and to resolve ambiguities—many individuals have multiple AD user accounts.

Consolidation of the AD child domains into the NIH domain is underway. When completed, it is planned that NED will bidirectionally synchronize locator information with user account entries in the NIH AD domain.

## NIH Login

[NIH Login](#) allows users to authenticate using their [NIH Active Directory](#) account. Once authenticated, a user may access any NIH Login-enabled application without needing to re-authenticate, for a limited period of time. Moreover, these applications are not restricted to run under Microsoft Windows. Applications enabled for NIH Login include:

- NEDWeb and NEDWeb Self-Service
- [NIH Portal](#) (my.nih.gov)
- [Web Sponsor](#)
- [NIH Business and Research Support System](#) (NBRSS)
- [Integrated Time and Attendance System](#) (ITAS)
- [NIH Intramural Database](#) (NIDB)

Most of these applications internally identify people by their NIH ID number, and require additional information from NED. The NIH Login process supplies applications with the authenticated AD domain and user account name. Since NED also obtains this information via its connection to AD, NIH Login-enabled applications can look up the information they require in NED using the authenticated domain/user account name. And once an application has obtained an individual's NED entry, it can readily find their records in other NIH databases, such as HRDB, FPS2, JEFIC, and so on.

## Telephone Directory

NIH [Telephone Operator Services](#) uses the NIH [Telephone and Services Directory](#) to manage calls to the NIH main switchboard at 301-496-4000. NED provisions the Personnel Listing ("white pages") portion of this directory, which is based on [Conveyant Systems TeleDirectory®](#) software product.

A hard-copy version of the Personnel Listing is also published twice each year as part of the *NIH Telephone and Services Directory*. Using NEDWeb, AOs can control whether or not an individual is included in the printed listing.

## Integrated Time and Attendance System

NIH employees use the [Integrated Time and Attendance System](#) (ITAS) to track and report their work hours and leave, and to view leave and earnings statements.

ITAS is an NIH Login-enabled application which internally identifies employees using their SSN. NED's "live" connection to a table in the ITAS database provides the mapping between NIH AD domain/user account names and employee SSNs.

## NIH Clinical Center Library Patron Database

The [NIH Library](#) provides a comprehensive range of scientific, medical, and administrative information and support services to NIH researchers. The library uses [Innovative Interfaces' INNOPAC Millennium](#) product to manage information about its patrons.

AOs can authorize individuals for library services via NEDWeb. Each day, NED generates an INNOPAC-compatible file containing the name, NIH ID number, organizational, and locator information of all authorized individuals. When checking out materials or using other library services, the patron's NIH ID number is scanned from the barcode on their badge, allowing the library to verify authorization for library services and to contact the patron or their AO when necessary.

## Applications Using NED DB2 Tables

NED provides a "live" feed of nearly all its data to a set of [DB2](#) tables on CIT's IBM OS/390 mainframe, which is shared by many applications that require read-only access via SQL. The tables include individual identifying information protected by the Privacy Act, so CIT's [Division of Computer System Services](#) (DCSS) controls access to this information by authorizing only those OS/390 accounts used for applications approved by the NIH Privacy Act Officer. (See the [Accessing NED](#) web page for further information.)

Other useful data resides in DB2, such as the HRDB and the FPS2 and JEFIC data in the [NIH Data Warehouse](#), making it convenient for applications to join these to NED to obtain the additional information they contain. For example, a simple query can return the email addresses of all NIH employees who are eligible for retirement.

DB2 tables can also be accessed interactively from a browser through the [NIH Web SQL Processor](#), and by Oracle applications through the [Oracle Transparent Gateway for DB2](#).

### Web Sponsor

Sponsors of IBM OS/390 mainframe accounts can use the [Web Sponsor](#) application to manage them. Triggers on the NED DB2 tables update locator and organizational information in mainframe account records whenever it changes in NED.

### New Business and Research Support System

The [NIH Business and Research Support System](#) (NBRSS), based on [Oracle E-Business Suite - Enterprise Resource Planning](#) (ERP) software, automates financial management, property, travel, service and supply fund (SSF), research and development (R&D) contracts, and acquisition/supply business functions. Currently, only the NIH Travel System and the General Ledger/Federal Administrator components are implemented.

NBRSS is an NIH Login-enabled application which requires identity and locator information from NED and additional information from the HRDB. Once each day, a snapshot of the required information is transferred from OS/390 to NBRSS via [Connect:Direct](#) and imported into the NBRSS database in Oracle.

**Parking and Transhare**

The [Parking and Transhare System](#) (PARTS) automates the distribution and management of parking hangers for cars and [Transhare](#) public transportation subsidies. A [Parking Office](#) clerk scans the barcode on a customer's NIH ID badge to obtain the NIH ID number, which the PARTS system uses to immediately look up that person's record in the NED DB2 tables. By applying a set of rules to the information obtained from NED, PARTS determines and indicates to the clerk the products and services the customer is authorized to receive.

**NIH Intramural Database**

The [NIH Intramural Database](#) (NIDB) is an NIH Login-enabled web application with an Oracle database containing a compilation of current and historical information on all NIH intramural scientists, identified by NIH ID number, and their research. NIDB obtains NIH ID numbers and organizational and locator information from the NED DB2 tables via the [Oracle Transparent Gateway for DB2](#).

**NHLBI eDirectory and Provisioning System**

The National Heart, Lung, and Blood Institute (NHLBI) provisions user account records in its Novell Netware system and Active Directory child domain via a "live" [Novell Nsure Identity Manager](#)<sup>6</sup> connection to the NED DB2 tables. As part of this system, NHLBI maintains an LDAP-accessible directory of locator and organizational information for all people in NED on a [Novell eDirectory](#) server.

**NIEHS People Database**

Since the late 1980's, the NIEHS [People Database](#) has served as a central repository of identity, organizational, and locator information for workers at the [National Institute of Environmental Health Sciences](#) (NIEHS). This includes Employees, Fellows, Contractors, Volunteers, Tenants and Guests. In addition to servicing a host of administrative and science support applications (over 40 in all), the People Database is the primary source of information for the NIEHS Telephone Directory, the on-line People Locator web application (internal and external versions), the Active Directory, the Exchange GAL, and many Exchange distribution lists. The generation of computer usernames and the creation and disabling of computer accounts are handled by the People Database system.

The People Database, which resides in Oracle, has become increasingly aligned with NED. By the end of 2004, it will consist largely of information entered and updated every 30 minutes from NED, but with additional data and functionality that NED does not provide and that is maintained locally at NIEHS.

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<sup>6</sup> Formerly known as DirXML®

The road to success is always under construction.

Arnold Palmer

## FUTURE WORK

### Additional Connections

#### HHS Employee Directory

The [HHS Employee Directory](#) web site, managed by the HHS PSC, includes the name, email address, and other locator information for all HHS employees. Other HHS agencies download this information to populate the “foreign” entries in their directories and address books.

NED generates daily an import-ready snapshot of the data needed; however, the HHS directory has not been switched to use it—PH currently provides the HHS directory feed.

#### nVision

[nVision](#) is the successor to the [NIH Data Warehouse](#). The goal of nVision is to integrate data from NIH enterprise systems, especially the [NIH Business and Research Support System](#), to become a broad-based tool allowing NIH decision-makers easy access to corporate data via the Web.

A one-way connection from NED to nVision is planned.

#### Help Desk Customer Database

The Help Desk Customer Database supports the submission and processing of service request tickets for customer support provided by the CIT [Division of Customer Support](#) (DCS). It is a component of the [Remedy Action Request System](#) (ARS), the software product that DCS uses to perform this function.

A bidirectional connection between NED and the ARS customer database is under development. When completed it will:

- Join previously-created customer records to NED entries, thus associating NIH ID numbers with customer records. This is necessary because DCS must occasionally

create service requests for individuals prior to their EoD date; that is, before their NED entry and NIH ID number have been activated.

- Create customer records for all individuals.
- Update name and organizational information in the customer database.
- Bidirectionally synchronize locator information, which will help keep NED's locator information current, since help desk staff frequently confirm building, room, and work telephone number during customer contacts and update this information in the customer database.
- Deactivate customer records when individuals separate from NIH.

The customer database resides in a Microsoft SQL Server database. NED writes to the database via the proprietary ARS API and client library, and reads from it via ODBC.

## Expand Provisioning

NED **provisions** an external database/directory when it is the only means by which a record/entry for an individual in the scope of NED can be created in it. Currently, NED provisions the following systems:

- NIH ID Badge and Card Access System
- NIH [Telephone and Services Directory](#)
- NIH Clinical Center Library Patron Database
- [NIH Business and Research Support System](#) (NBRSS)
- [Parking and Transhare System](#) (PARTS)
- [NIH Intramural Database](#) (NIDB)
- NHLBI eDirectory
- [NIEHS People Database](#)

Provisioning is desirable because it:

- assures that records in external repositories include correct NIH ID numbers; and
- eliminates the complexity and high overhead of join rules.

Candidates for provisioning include:

- [NIH Active Directory](#) (AD)
- [NIH Portal](#)
- [Web Sponsor](#)
- NIH [Integrated Time and Attendance System](#) (ITAS)
- [nVision](#)
- Help Desk Customer Database

Provisioning would be more widely applicable if NED allowed records for individuals who have been hired, but not yet begun active duty, to be created and updated in selected systems; for example, the Help Desk Customer Database.

## Improve Deregistration

NED has greatly improved, but not solved, the problem of reliably deregistering individuals when they separate from NIH. Thus, NED's largest data quality problem is the thousands of incorrectly active records for people, primarily Contractors, who are no longer affiliated with NIH, but have not been deregistered. Fundamentally, NIH has no timely business process for NED to hook into that is reliably performed when unpaid/non-visiting workers leave.

Some improvement could be realized by auto-deregistering individuals after their ID badge expires—but an individual could be gone for up to two years before this occurs, and not all individuals are issued ID badges.

## LDAP Access

NIH application developers have requested access to NED data via LDAP, and this was also one of the goals originally set by the AMG TSC for the project. While the NHLBI eDirectory provides LDAP access to most organizational and locator data, it does not contain identity data, which requires controlled access.

An attractive option would be to maintain a copy of NED data in an [Active Directory in Application Mode](#) (AD/AM) server, which would allow access to identity data to be controlled by means of existing user account and group entries in the NIH Active Directory. After consolidation of the AD child domains into the NIH domain is completed, these user accounts would be the same as those used for NIH Login.

## **Manage Organization and Buildings Data**

NIH organization and buildings data has some of the same problems as its people data, though on a smaller scale:

- No database contains records for all organizations or buildings.
- No database contains all desired data elements.
- Organization/building names and abbreviations differ across databases.
- Data is not updated soon enough for use in NED.
- Data quality is lacking: missing/invalid values, inconsistently coded values, old data.

Since NED and the applications to which it connects require organization and buildings data (for example, to create drop-down lists for data entry in user interfaces), and since the problems with this data are similar to those NED already solves for people data, this suggests using the JE to combine, synchronize, and distribute organization and buildings data among other systems and databases. One of these systems would be a NEDWeb-like application for use by AOs to provide data not available elsewhere and/or not available as soon as needed.

## **Support Groups of People**

The JE can manage entries that represent groups of people; for example, all people who:

- work for a particular IC,
- work in a particular building,
- are Employees, or
- are authorized to access a particular application or resource.

Either the JE can determine who belongs to a group based on the contents of their entries in NED, or it can obtain the list of group members from an external source.

The JE can then synchronize groups across external systems and applications, translating people identifiers as needed. For example, the JE could maintain a group for each IC of all people who are currently affiliated with it, and flow these groups to AD and an email list server. Within NED, group members are identified by their NIH ID numbers, but the JE could convert these to the DNs of the corresponding user accounts for the AD groups and email addresses for the email list server groups. The AD groups could then, for example, be used to allow only individuals in a particular IC to access a file, and the list server groups to send email messages only to individuals in a particular IC.



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